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DISTRICT HEATING AND COOLING
Experiences of Eight "Phase II" Cities

by
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A NOTE TO THE READER

The HUD Phase II district heating and cooling case studies reported on in this document are a unique source of guidance to those poised to consider a new or expanded district heating system. The authors of this note to the reader have administered HUD's end of the work discussed in this report. Our own experience and perceptions are reflected very closely in what the report says. Even so, a word from us is offered here to emphasize certain lessons learned in the context of conducting related community development-oriented DHC activities supported by HUD and the Department of Energy.

In his Conclusions section the report's author, Michael Meshenberg, AICP, points out that for the participating cities the product of their community's DHC Phase II efforts "was seen not as a report but an RFP for an owner/operator" of the desired system. "RFP" means a request for a proposal - in this instance for the purpose of enlisting the participation of a DHC system developer and/or owner/operator. For most cities that would imply negotiations with private investment sources. In other words these places, which had come up with a two-thirds financial match for their HUD Phase II grants, were involved expressly because they wanted to see new DHC investment result. Such was the Federal perspective from the start as well. HUD's grants were awarded competitively on the basis of investment promise as a principal selection criteria.

Great effort and expense go into DHC developmental work. Entering it implies a reasonable expectation of success in creating, at very least, a 'start-up system' of some description. In the selections HUD made, the prospects for success were assessed by outside reviewers with sufficient experience to appraise the likelihood of success. Yet the odds of success declined during the period these projects were in development owing to the sharp decline in oil import costs. What that means for those seeking to interpret these case study experiences deserves further discussion, for both oil and gas prices are at this writing once again on the rise.

We assume that the economies of cities which already possess effectively performing DHC systems stand to gain. We assume, that is, that (a) DHC's many cost efficiencies are desireable to have in place and (b) such benefits are to become proportionately far more valued should fuel costs continue to re-escalate. We also assume that (c) it is easier to expand an existing system than create a new one. Investors are currently validating these assumptions as we see the systematic acquisition under way of established DHC systems. Given these asumptions, therefore, where none exists there is real value in getting a city's DHC system started, even if on a small scale.

Another premise that has undergirded HUD's grant support for DHC is that, (d) once adopted as an objective, the creation of new DHC systems needs to proceed as a collective effort on the part of key local interest groups. HUD's requirement for advisory working groups (or AWG's) in these Phase II projects is designed to give this investment in DHC development packaging its best chance of fruition. When a city engages a cross-section of people to get acquainted with its DHC potential, there results a build-up of resolve, of technical grasp, of local institutional memory and of political power that is the best insurance that, when timing is right, a system can be promoted.

A premise, coming out of present experience has to do with the value of doing formal DHC studies per se, for (e) once a round of substantive DHC study has been completed and endorsed by the advisory work group, critical ideas, analysis and awareness needed in building a new system are at hand to support the reaching of decisions for any alternative configuration. A corollary here is that (f) with a new system put into motion the momentum for introducing additional systems - that is, ones not necesarily connected to the original - may become much greater.

We have seen how difficult it can be to create a totally new system, given the complexities of DHC's legal, financial, institutional and political contexts. Despite these complexities progress has been made in the cities reported on in this report. What makes the most difference besides competent, steadfast pursuit of a system (besides leadership) has been customer interest. That, of course, is a function of anticipated cost-savings, and that is directly impacted by competing fuel costs.

One final assumption is offerred, regarding fuel. Taken as a matter of local economic interest, (g) it benefits a local economy to reduce the amount of money exported for fuel. Fuel costs become reduced through DHC. In most places this savings gets retained as capital for local investment - capital which has a multiplier effect (Minnesota finds that to be in the range of 2.62 times the energy cost savings.)

In summary, these projects demonstrate that the development of a DHC system creates an important community asset. The process is complex, and it is strongly influenced by variables not all of which can be controlled by the system's proponents. For communities concerned about long-term stability of energy costs, one of the most important ingredients in their economic efficiency and competitiveness, district heating and cooling or DHC, is an asset now warranting their deliberately focused attention.

Wyndham Clarke, Government Technical Representative, HUD
Andrew Euston, Government Technical Monitor, HUD

1 INTRODUCTION

Reported on here is the work of eight cities which had expected, by now, to be close to constructing new district heating systems. Each had participated in the joint HUD and DOE program to explore prospects for district heating initiated in 1980 and each had, as a result of that first study, high expectations for success. The exploratory Phase I work has been followed by a much more detailed Phase II technical and economic analysis, in most cities supported in part by additional HUD funds.

The positive expectations at the start of Phase II have been realized in several of the cities. Provo's new downtown system is operating. Baltimore's old downtown steam system has been sold to a private operator and is being fed by a brand new trash-fired incinerator. Expansion plans are in the works. New York and Springfield may begin construction as soon as final financing details are resolved.

The emergence of a Columbus system is slowly taking shape, following a well-publicized study by the Danish government. A developing industrial park in Lewiston may include district heating, but the expected system serving the old downtown mill area seems remote. The prospects for district heating to serve industry, a college, and downtown Holland, originally so promising, have now dimmed. And, finally, the most prominent success story to emerge from the original 28 participants in the HUD/DOE Phase I program, Lawrence, not only may fail to expand but may even have lost ground in the face of oil price reductions.

This report, then, summarizes and analyzes the process and results of work conducted under Phase II, concentrating on how and why final results have differed, sometimes dramatically, from earlier expectations. Written primarily for local planners and officials, it discusses the development process and how results were arrived at, giving relatively less detail on the particular characteristics of each project. These are presented in the eight individual case studies from which this report is derived.

District heating usually represents a major capital investment in plant, transmission/distribution lines, and modification of the customers' buildings. The design and investment decision-making process is long and complex, and highly dependent on local, national, and even international conditions, particularly related to the price of fuels. While construction of a system defines success, the initial lack of construction should not be judged a failure. Studies that have been done and plans that have been drawn up may later form the basis for successful project implementation. And as people in a city go through the process of DHC development, momentum may be set in place that can make subsequent "go" decisions possible.

1.1 STUDY BACKGROUND

All eight cities discussed in this report were among the original 28 cities participating in a program initiated by HUD and DOE in 1980 to explore the potential for district heating in cities throughout the United States. DOE had pioneered in the study of technical and institutional issues and had assessed diverse types of district heating/cogeneration systems, using national laboratories and other resources to do the research.

The promising results of DOE's work stimulated HUD's interest in considering the potential of district heating to support community and economic development by helping to lower and stabilize fuel costs, particularly in older central cities. This interest led to the emergence of the National District Heating and Cooling Assessment Program under which HUD and DOE supplied funds and management assistance for cities to conduct exploratory feasibility studies and DOE also supplied technical resources and information to the 28 cities that had competed successfully for Cooperative Agreements.

The studies conducted by the 28 cities showed that it was feasible in about 17 of the cities to successfully develop a district heating system that would serve broad community objectives. HUD and DOE felt that getting as many as 25 percent of the participants into operation would be deemed to be a major success. Recognizing that further federal support was needed to help cities move from concept to reality, HUD issued a second RFP, limited to those of the 28 cities, and others that had conducted similar feasibility studies with positive results. This Phase II effort was intended to produce "financeable projects," i.e., needing only final engineering design and financial packaging to begin construction. Six cities were awarded Cooperative Agreements under this program, three each in two rounds: Baltimore, Lawrence, Lewiston, New York, Provo, and Springfield. Holland later decided to proceed relying exclusively on local funds. And Columbus was chosen by the Danish government as a case study of the application of European district heating technology to U.S. conditions. These eight cities are discussed here.

As with the original 28 cities, Argonne National Laboratory was asked by HUD to monitor the progress of these cities, write case study reports, and summarize the results. In Phase I, and to a lesser degree in Phase II, Argonne staff also supplied the cities with technical assistance on request. Information for the case studies was obtained by ANL staff from on-site field trips, documents provided by project managers and HUD, telephone conversations, and attendance at annual HUD and DOE-sponsored national district heating conferences.

1.2 ACKNOWLEDGMENTS

The author acknowledges with appreciation the assistance of project leaders in the eight cities who provided much of the information -- both in interviews and in documents -- for the case studies on which this report is based. Staff of HUD's Energy Division, sponsors of this work, have provided valuable insights and comments through the course of the study and particularly on the prior draft of this report. Thanks go to Robert Groberg, Division Director, and to Andrew Euston and Bernard Manheimer. Finally, and most important, Wyndham Clarke, the Energy Division's manager of district heating studies, has made a major contribution in shaping the government's role in district heating. His advice and support has been invaluable in writing this report.

2 BACKGROUND ON THE EIGHT CITIES

2.1 INTRODUCTION

The eight cities included in this analysis are a diverse lot. They range from Holland with a population of 26,000 to New York City with 7,000,000 people. Except for Provo, all are Northeastern cities. Many are older cities whose economic base has been changing in the face of competition from Sun Belt cities and from overseas. Each saw district heating as one part of a broader development strategy to improve its competitive position, strengthen its business conditions, and lower housing costs. Each similarly saw district heating as fulfilling a unique local role and with potential for serving particular customers.

Table 2.1 summarizes selected characteristics of the eight cities. Figure 2.1 shows their locations. Brief narrative descriptions follow.

2.2 THE CITIES

Baltimore. The current state of district heating in Baltimore is considerably different from that which was expected at the end of Phase I in late 1982, and even as the the Phase II work proceeded. Phase I identified an under-construction 2250 ton-per-day refuse-fired cogeneration facility as the principal heat source. This would serve two areas: Cherry Hill, with large public housing complexes and other users about two miles southeast of the facility, and Hopkins/East Baltimore whose "anchor" loads would include the City Jail, the State Penitentiary, several public housing complexes, and schools. For the latter system, heat would be "wheeled" from the new facility through the existing district heating system serving downtown and owned by Baltimore Gas and Electric Co. Both projects would be staged to expand over time.

Things have changed. The public housing projects in Cherry Hill were forced to replace obsolete heating systems with more modern equipment before they could be economically connected to the existing downtown system. Instead of installing gas-fired boilers, the Baltimore Housing Authority renovated the Cherry Hill central system as a campus-type district heating system to be compatible with the downtown district heating system. And, perhaps most significant, BG & E has sold its downtown system to Youngstown Thermal Corp., which is purchasing steam from the new refuse plant and is looking to expand the system gradually to Hopkins/East Baltimore and later to Cherry Hill and other parts of the city.

TABLE 2.1 Summary of DHC Project Characteristics

	City Population (1980 or current estimate)	Main DHC Project Heat Source	Fuel	Heat Only or Cogeneration	Fluid	Major Users Identified at End of Phase 1	Current Status
Baltimore	783,000	Refuse incinerator	MSW	Cogen.	Steam/hot water (hybrid)	1. Cherry Hill: Public and private housing; schools, 2. Hopkins/E. Balt.: Pub. hsng, jails, schools	Existing CBD DHC system sold to Thermal Resources of Balt. (Youngstown Thermal), looking to expand first to E. Balt. then elsewhere. Eventually may serve Cherry Hill pub. hsng., which has been retrofit to accept DHC.
Columbus	593,000	Coal boiler	Coal; gas peaking	Cogen.	Various, mostly hot water	Ohio State Univ., part of CBD mixed use area between	Several possible projects identified. Sources: MSW-fired power plant, old munic. power plant, temp. boilers. No implementation actions taken.
Holland	26,000	Munic. Power plant	Coal	Cogen.	Hybrid	Industry, Hope College, CBD	Possible project found feasible; implementation stalled because of reluctance of 3 key customers to commit.
Lawrence	65,000	Refuse incincerator	MSW	Cogen.	Hybrid	Mills, pub. housing, residential	Plans for expansion of newly-built system on hold. Tech. problems, drop in oil prices, loss of local consensus main obstacles.
Lewiston	41,000	Refuse incinerator	MSW; oil peaking	Cogen.	Hybrid	Mills, CBD environs, adjacent residential	Anticipated downtown system unlikely; new private system at indust. park may proceed using wood chips for fuel.
New York	7,000,000	Retrofit boilers	Gas, oil	Cogen.	Steam	Indust. park, possibly pub. hsng; 2 other possible projects	Brooklyn Navy Yard system, also serving 5,000 pub. hsng. units, likely to proceed under private ownership. Engin. & financing moving forward.
Provo	74,000	Munic. power plant	Coal	Cogen.	Hot water	High school, hosp., possibly BYU	New DHC is operating, using cogen. heat from retrofit munic. power plant.
Springfield	165,000	City Hall boiler; later, waste-to-energy plant	Gas; MSW later	Cogen.	Hot water	CBD & environs	Downtown system being developed by a private operator. Strong prospects for successful implementation.

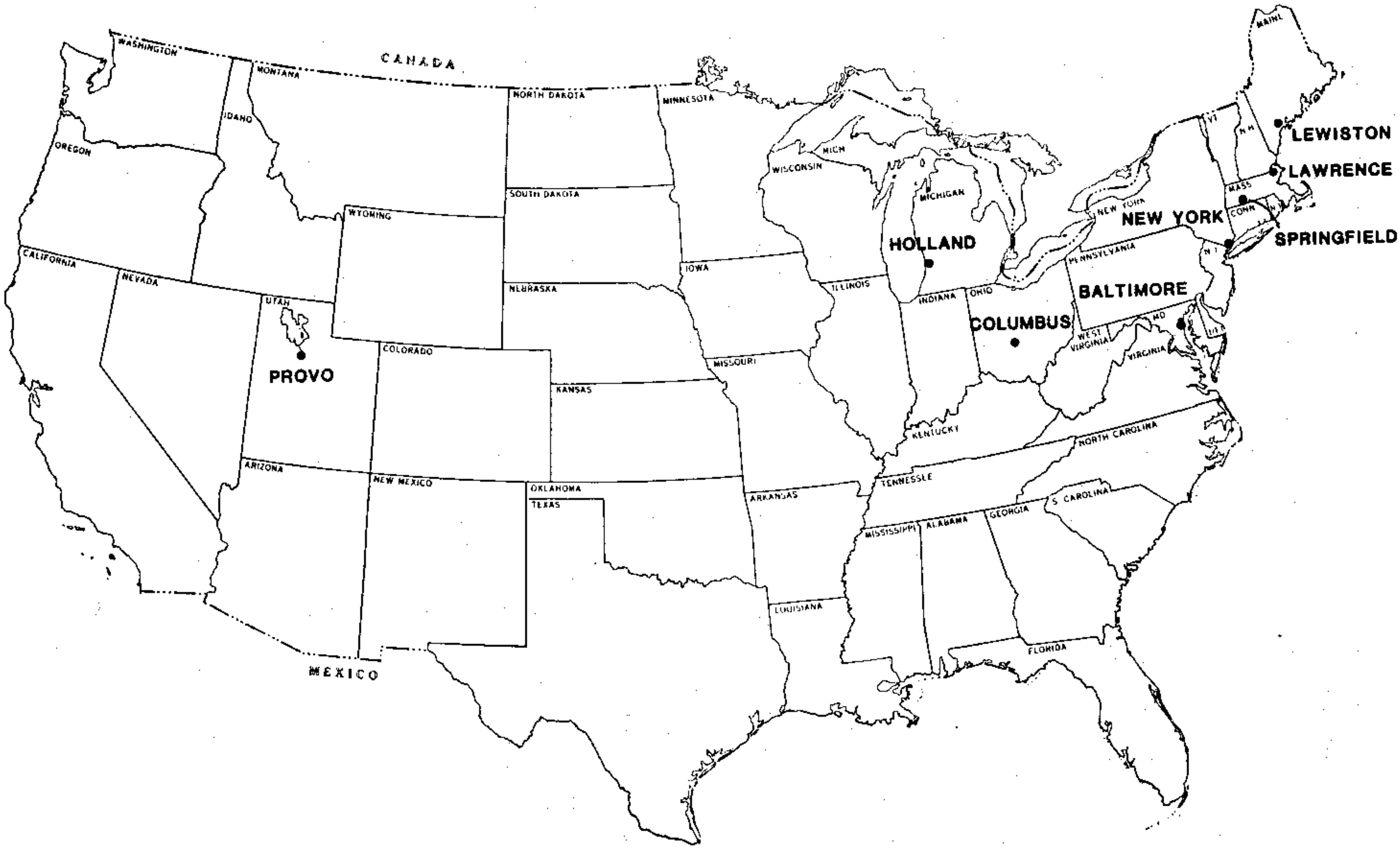

FIGURE 2.1 Cities Participating in the Phase II Program

Thus, while the configuration of district heating in Baltimore differs now from what was initially expected, distinct progress has been made, and expansion prospects are favorable. Substantial credit must be given to the years of effort by the City and the federal financial and technical support received.

Columbus. A chart of progress on district heating in Columbus would show several peaks of high expectations and valleys of disappointment and uncertainty. The Phase I study results proved to be inconclusive, providing an overview of possible city service areas but not focusing on specific projects. Prospects for district heating in Columbus seemed pretty bleak.

But the Danish government, looking for a U.S. city in which to demonstrate application of European district heating technology, saw real potential in Columbus. Expert consultants brought in by the Danes under an international agreement identified several possible "heat islands" that could be served separately at first and later joined into a single system.

Attention centered on the recently completed Columbus refuse and coal-fire municipal electric power plant with a capacity of 3,000 tons per day, and an ability to generate up to 90 megawatts of electricity. The plants could also be used to supply a nearby prison workhouse with peak capacity heating requirements. Later stages could serve a planned state penitentiary hospital, a conference center, and possibly downtown Columbus and a nearby redevelopment area.

Despite favorable economics and sound technical planning, however, firm development commitments have yet to occur. There is some question about the financial health of the power plant and resolution of the issues may take a long time. City elections and turnover in senior staff put service to the workhouse on hold for a period. Potential district heating developers have come forward, but earnings projections have held back firm offers.

The new mayor has endorsed district heating and studies, analyses, and a search for developers continues but without promise of city capital contributions. Prospects, though uncertain, are certainly not dead as the negotiations go forward.

Holland. In contrast to Baltimore and Columbus, the basic configuration of a district heating project in this small Western Michigan city has not changed from the outset. The city has its own coal-fired municipal electric power plant just a few blocks from downtown and within a mile or so of several large factories, city hall, and Hope

College. Study has always focused on retrofitting the power plant to supply cogenerated heat to serve these customers. Financing was not viewed as a problem, since the municipal utility has the authority and capacity to manage projects of this nature. Once a system was started, prospects for expansion seemed favorable.

But with all these things in its favor, implementation has not yet begun. To begin construction, the city needed long-term heat purchase commitments from at least three anchor users, the two industries and Hope College. One industry, absentee-owned, seemed little interested in district heating, despite analyses showing that its thermal energy costs would be lower. With the continuing drop in oil prices, its low interest further waned. The other two anchor users also have grown uneasy at the prospect of signing a long-term commitment to contract for district heat.

Talks continue, but prospects for a Holland system, once so promising, now seem dormant at least in the near future.

Lawrence. Lawrence, a city with a large refuse-fired heat source, was the "star" of Phase I. A project intended only to explore district heating feasibility resulted, in Lawrence, in the actual functioning of a system within the course of about a year. A fortuitous combination of circumstances led to this success.

Private initiative and aggressive public support made Lawrence a national showcase when it opened its resource recovery thermal conversion facility in 1984. The system was conceived originally as solely an electric power production facility under private ownership. The city used its original Phase I assessment funds to determine whether the plant could also generate thermal energy for sale to local customers. The responsive developer of the facility accepted the city's recommendation and was well along in construction of the first section of a steam line even before the assessment project was completed. Customers included several mill buildings and two public housing complexes.

This project was seen by city leaders as a major vehicle for the continued upgrading of a once-thriving mill-based economy that had come onto hard times.

The Phase II work looked at expanding the system to serve a number of mills in an old industrial park along the Lawrence canal system, and a relatively poor residential neighborhood adjacent to the thermal conversion facility.

Despite economic and technical analyses that showed good prospects for expansion and interested private developers, likelihood of movement has severely declined, for at least three reasons:

1. There have been serious technical problems in operating the new steam line, shaking the confidence of prospective customers.

2. The rapid decline in oil prices has made district heating less competitive, at least over the short term, causing one major customer to disconnect from the system.

3. Finally, the broad private and public consensus and partnership that propelled the initial project forward has dissipated. Summer unrest among some city residents has occupied the attention of city leaders. City leadership has changed. No one in town is championing district heating. The city's Refuse-to-energy company can make more money selling electricity than steam.

Circumstances have led Lawrence to move on to other issues. In this climate, district heating is no longer a local priority and is unlikely to become one, at least until energy prices rise significantly.

Lewiston. As cities, Lawrence and Lewiston have many similarities. Both developed as textile-based mill economies with energy drawn from hydropower. Major employers are within a stone's throw of downtown, but the economies of both have been in decline for years. Both looked to refuse as district heating sources.

But there the similarities end. Where Lawrence had a system running at the end of Phase I, Lewiston had a long way to go. A possible site had been chosen on vacant riverfront land near the mill complexes, fuel mixes had been identified, and institutional support seemed strong. But many design, financial, and legal hurdles remained. Prospective customers showed support by financially participating in the Phase II study.

The initial Phase II analysis established that the sale of heat would not produce revenues sufficient to support construction of a heat-only power plant. Cogeneration was essential, to the point that about 90 percent of all revenues would be derived from sale of electricity. Thus, the sale price of electricity (and related technical considerations), became the determinants of economic feasibility.

Once this became clear, Phase II work focused on preparing an application to the Maine Public Utilities Commission to sell cogenerated electricity to the Central Maine Power Company. However, the avoided cost figures offered for electrical power to be purchased from the Lewiston system were too low to provide a sufficient return to attract investors. The original project, so dependent on the sale price of electricity, was not feasible.

During the study period, a substantial investor introduced wood-fired technology into the major mill customer's network only to find oil prices dropping below anticipated levels. It was forced to close down and return to the old boilers.

Yet work on district heating in Lewiston could still bear fruit. Two private developers have expressed interest in building separate systems, one in approximately the same service area studied by the city, but taking over the wood chip system, and the other a waste-to-energy system at a developing industrial park on the city's outskirts.

One or both of these systems may be operating within the next few years, a direct outgrowth of the engineering and economic studies conducted by the city, with private support.

New York City. A financing package has been assembled, with participation by several private and public entities, to build a private district heating/cogeneration system to serve the Brooklyn Navy Yard industrial park and 5,000 units of adjacent public housing.

New York's Phase I study identified several likely district heating candidates. But Phase II was limited to the BNY area because of the extraordinarily high energy costs paid by the industrial tenants, (45 firms employing 2,200 workers), the opportunity to serve public housing with a modern, reliable system, and the great benefits that could accrue to the surrounding neighborhoods. The 261 acres of the park are located on prime waterfront land and it is operated by the Brooklyn Navy Yard Development Corporation under a 99-year lease from the city. An interim steam central heating and electric distribution system exists at the Navy Yard and electricity is purchased from the local utility.

Neither the city nor the BNYDC had any interest in owning a district heating/cogeneration system. As a result, about midway through Phase II, when an initial design and financing scheme had been completed, the city requested proposals from private firms to build, own, and/or operate a system. Months of negotiations ensued while other studies were done to answer many of the remaining technical and financial questions.

A developer has been selected and negotiations are continuing. Discussions centered on configuring a financial package that would provide long-term service assurances to the customers and a satisfactory profit to developers, while limiting the city's liability. Total estimated cost of the system is about $20 million, to be financed through a combination of tax-exempt bonds, private equity raised through either a leveraged lease or a limited partnership, and a recently-granted UDAG loan. The City's share of the profits would be used to finance further capital improvements in the Yard.

Provo. Provo is a district heating success story. In 1984, the City Council unanimously approved construction of a hot-water cogeneration system, ground was broken for the $1,500,000 line in early 1985, and service began with the 1985-86 heating system.

The basis for the system is the retrofit of the city's municipal coal-fired electric power plant to cogeneration and using otherwise wasted heat to supply buildings near the plant. The Utah Valley Hospital and new Regional Medical Center, Provo High School, a recreation center, and other buildings near the plant are being heated by steam from the plant, replacing on-site gas heat.

Eventually, the district heating system may expand to serve Provo's downtown business district and the power plant may also be retrofitted to burn refuse-derived fuel. The existing district heating system serving the Brigham Young University campus may also eventually be linked with the city system.

This project is substantially different from that initially configured. That system was much larger, intending to serve BYU and other large heat loads, and would have cost as much as $50 million, beyond the capacity of the city to pay. The Phase II analysis was much more limited in scale, focusing on developing a smaller, financeable project, one that would target areas of the city in need of the service, while offering substantial expansion potential.

Provo represents a good example of thinking small at the outset and growing as the system is proven to function well and within financial means.

Springfield. Springfield is a typical mid-sized Northeastern city whose economy had suffered serious decline in recent decades. It looked to district heating as a way to provide energy stability to its downtown area and to help service the private and public entities that had invested heavily in restoring economic health.

The Phase I study identified several potential heat sources which could serve as initial heat suppliers, to be replaced later by hot water generated at a new refuse-fired facility located directly across the Connecticut River from downtown.

Major work in Phase II involved engineering and financial analysis leading to the issuance of a solicitation for a private developer to build and operate an initial "start-up" downtown system. Energy Networks, Inc., a holding company for Connecticut Natural Gas of Hartford and the Hartford Steam Co., was selected as the developer. The project now appears headed for successful implementation, having diverted from the studied configuration to one based on an entirely new development investment.

To be built in stages, district heating in Springfield serves to further support the already considerable investment that has sparked the city's economic rebirth. In several years, a major heat source, the city's new waste incinerator, will come on line to provide lower-cost service to a large section of downtown.

3 PROJECT DEVELOPMENT PROCESS

The individual city summaries in Chapter 2 hinted at the complicated path most of the cities followed in moving from initial district heating conception to the present. Some have succeeded and some are likely to move to implementation soon. And in the remainder, implementation is uncertain until local or national factors change. The process was never easy. In most instances, the final design, whether successful or not, evolved differently from the original concept and even from that chosen for study in Phase II. Federal involvement and technical support in working with the cities and the developers provided important continuity, even when local officials or staff changed.

This chapter presents the project development process, discussing who participated directly and indirectly in decision making, and the internal and external forces that helped shape the final results.

3.1 DEVELOPMENT PHASES

When the cities responded to the HUD/DOE RFP in late 1980 they may not have realized the type of commitment and the time frame involved in bringing the concept to reality.. District heating was an attractive idea, an energy and cost-saving opportunity to improve the city's economic position. Few at the time knew much about the technology nor about the intricacies of the studies needing to be done, the financial packaging required, and the years of negotiations that would ensue. Yet, all completed Phase I, many were able to define feasible projects, and a tremendous amount was le arned about the process to share with others. One or two fortunate communities have been able to short-circuit this process, mainly because a private entrepreneur has emerged to build, own, and operate the system. But even in those communities, private participation occurred because of the groundwork that had been laid by the work in the studies.

Theory has it that the project development process proceeds through a series of phases starting with preliminary project identification, and continuing through feasibility analysis, engineering and financial design, project packaging, marketing, obtaining financial commitments, construction, and, finally, operations. The initial HUD/DOE cooperative agreements provided funds for Phase I project identification which in most cities was a process of narrowing opportunities to the projects likely to have the best chance of success.

In Phase II, the objectives as identified in the RFP were to carry the most feasible project to the point where it was ready for final design and financing. To accomplish this purpose, HUD required each city to develop a work plan and schedule of steps, with a final report to be prepared by a specified date, 12 to 18 months hence.

Original projections of time required were, in most cases, optimistic. This was not surprising; work planning for such a complex venture is not a science. Original completion dates were extended, in some instances several times, for periods up to three years, but at not additional cost to the federal government. The HUD-required steps served frequently as overall guidance to the cities as they attempted to configure projects that could be financeable, while meeting community needs, but were not seen as precise work outcomes. The principal roles of the work plans were to guide consultant work, but even this was frequently varied from initial expectations as local circumstances took over, but their principal purpose -- to balance technical design work with other aspects of project development (law, finance, marketing, institutional readiness -- was realized.

Table 3.1 provides a detailed overview of the evolution of the projects in the eight cities from from original conception to now. It identifies:

- The original Phase I study and results.
- Activities that occurred between the end of Phase I and the beginning of work on Phase II. This undefined period sometimes lasted as long as one and a half years.
- Expectations at the start of Phase II.
- Results of Phase II.
- Current state of project readiness: where things are now and expectations for the future.

3.1.1 Phase I/Phase II Transition

Phases in the project development process are not neatly demarcated. To show the progress or changes that occurred in most of the communities between the end of Phase I and the beginning of Phase II, a transition phase has been included in the individual city descriptions im Table 3.1.

TABLE 3.1 DHC Project Evolution

	Phase I Results	Phase I-II Transition	Phase II Activities	Phase II Results	Project Readiness for Implementation
Baltimore, Maryland	Completion: Sept. 1982. Cherry Hill: BRESCO transmission loop to Cherry Hill; heat exchanger; second HABC distrib. loop; other users Balt. Gen'l hosp; school; more pub. hsng. Total cost: $8,264,000; bldg retrofit, another $4,694,000. Hopkins, E. Balt.: City Jail, State Pen.; pub. hsng, schools. Either new gas boilers or "wheeling" steam from incin., thru BG&E system. Hybrid: core on steam; HW in outlying areas $3,807,000 t/d; $3,92,000 end-user retrofit.	HABC & BRESCO decided to replace Cherry Hill Homes steam dist. system & in-bldg heating system with HW system compatible w/DHC. BRESCO installs extraction turbine at Southwest Facility which could provide HW to Cherry Hill DHC.	Start: Late 1982. Study both Hopkins-E. Balt. & Cherry Hill, Cherry Hill priority. Basic role: decide concept design for firm agreement between both parties. Study team; tech/eco. group: design specs, pricing; tech/engin.: trans. line, load estimates, customers; legal/ inst.: regs, contracts.	June 1983 Key issue: route optimization. Selected route using mostly existing R-O-W @ $3.5M -- lower than earlier estimates. Construction in Phases. Hopkins-E. Balt.-Youngstown Thermal looking to expand -- probably before Cherry Hill.	June 1983 - Stalled progress because: decline in avoided cost of elec.; who controls solid waste; role of BRESCO as DHC developer. Sale of BG&E system (city gave expanded franchise); complications in bidding process to build HW trans. line to CH; need for HABC to buy thermal energy at lowest cost (BRESCO couldn't match).
Columbus, Ohio	Dec. 1982 Initial study considered 3 "heat islands" including OSU & areas south & east of CBD. Assumed existing CBD DH system would eventually tie in. Various scenarios studied; considered economically feasible. No focus on small "doable" project or on implementation. Called for more study, focusing on downtown.	Negotiated agreement between city & Danish Ministry of Energy, signed 12/3/82.	Start: Dec. 1982 Focus on small projects to start. Looked at: (1) area around new Trash Burning Power Plant (TBPP) to serve prison workhouse & mixed use area; (2) CBD, using unused munic. power plant; (3) brewery waste heat serving nearby area, incl. hospital.	Aug. 1984 Conclusion: (1) & (3) are both feasible, with delivered energy far cheaper than now. CBD is now being studied under a new DOE grant.	No implem. actions: - TBPP plant cost overruns; complex financial issues need to be resolved first. - Change in city admin. - No developers emerged. - Danish consultants not tied into city. - No local "champion."
Holland, Michigan	July 1982 Looked at using excess heat from downtown munic. power plant to serve several industries, Hope College, CBD, Holland Munic. Hosp., city bldgs, proposed riverfront dev't. Phase I finds economical 2-loop system -- 130 psig steam to industry; 25 psig steam -- Hope College, CBD; possible expansion to others @ $14-15M.	Summer '82-Fall '83 HUD applications; no progress. City decides to proceed on its own with local funds in late 1983 -- 4-5 month consultant selection process.	Start: Feb. 1984 -- expected 7 month study: (1) end-user consumption; (2) T/D system; (3) power plant retrofit; (4) eco. analysis, pricing; (5) implem. plan; (6) present to end-users. Little mkting, or legal, ownership analysis since under BPW sponsorship. Work group: BPW staff & consultant.	Jan. 1985 1. 125 psig steam loop to Heinz, Parke-Davis. 2. 250°F HW system for Hope College & CBD. DHC system would be supplied thru reboiler completely separating internal/external systems. Total cost: $14,259,000 exclusive of end-user retrofit -- Hope College: $600-900K. Economics found to be favorable -- all customers save (CBD figures need to be specified for each customer).	Project stalled -- Heinz unwilling to commit, lower gas prices made DH noncompetitive to Hope College; no other mkting activities.

TABLE 3.1 (Cont'd)

	Phase I Results	Phase I-II Transition	Phase II Activities	Phase II Results	Project Readiness for Implementation
Lawrence, Massachusetts	Completion: Late 1982 Narrowly focused on retrofitting for cogeneration an under-construction resource recovery facility to supply steam to industry & public housing. $90M project starts construction June 1982.	Little gap -- got Phase 2 money early. Construction of Thermal Conversion Facility continues (completion: Summer 1984). Plans for Steam Line #1 proceed.	Funds rec'd: early 1983 ($80,000 total). Objectives: can powerhouse also serve (1) NCIA industries; (2) Arlington Neighborhood, preferably under pvt. ownership & operation?	April 1985 Proceed with NCIA project in phases, using private owner/operator. Proceed in Arlington with small demon. project under NHS auspices, expand in stages to the entire neighborhood -- financing thru weatheriz. funds, UDAG repayments, and private equity. The two projects may need to be paired.	None -- perhaps lost ground. Why? (1) falling oil prices made oil more competitive; (2) serious mechanical breakdowns in new plant & steam line; (3) better deal on price of elec.; (4) change of political, staff & consultant leadership -- diminution of local consensus; (5) no developer clearly identified. Outlook: dim.
Lewiston, Maine	Sept. 1982 Primary service area: concentration of mills near CBD, with secondary service to nearby resid. area. Proposed new MSW/coal (wood) cogen. plant. Total cost: $31.6M. Ownership/financing not detailed.	Sept. 1982-Sept. 1983 Key changes: (1) oil price sunk below price of wood per Btu equiv.; (2) wood supply network growing; (3) several mills lost interest; (4) prospective college site no longer considered. But little active study, design work done.	Started Sept. 1983 9 mos. to work out work plan & get consultant started, with active HUD partic. Cost: $185K split betw. HUD, DEP & local (city, industries). Most work focused on optimizing a project that could meet utility avoided cost rates for elec., while keeping DHC prices competitive. 7 of orig. 14 anchor customers remained on AWG.	May 1985 Driven by elec. production requirements, 450 tpd MSW/wood mass-fired cogen. plant @ 650 psig, 750°F to drive steam turbine, expanded for steam/HW for DHC system. Cost: $3.6M. Revenues (1989) Elec: $6.4M; tipping fees: $.8M; heat: $.7M (heat @ 85% of No. 6 fuel oil). Intent was to attract a "full service operator" to build own system (calculated based on 27% after tax ROI).	Project viability dependent on elec. price; CMP price too low; project now economically infeasible. But two private developers considering cogen. system, one at indust. park, one downtown, with no city partic.
New York, New York	Late 1982 Broad citywide look at possible DHC sites. 3 possible projects: (1) SW Brooklyn incinerator area; (2) Kings Co. Hospital; (3) Bklyn Navy Yard, all considered viable.	Fall 1982-Mid 1983 Decided to focus on BNY project -- greatest potential & need	Contract signed July 1983 (expected completion Dec. 1984) $320,000K cost. City, private, NYCHA, HUD contribute. Issue: Determine load characteristics, configure plant/dist. system, secure permanent financing. RFP issued Dec. 1983 for full-service owner/operator. Negotiations, technical & financial analyses lead to designation of Montenay, Nov. 1984. Additional tech/eco. studies done, further delaying decision.	HUD work done: Jan. 1985 Developer designated, cogen. project design & pricing laid out, draft contracts with BNYDC tenants & NYCHA have been negotiated. End of HUD contract was not end of work. Detailed financing, engineering design, & contracting yet to be done. Project: $28M. Final project config. surprisingly similar to Phase 1, 4 years earlier.	Construction hasn't started yet. $1.85M UDAG loan has been received; financing pkg. developed, but not yet in place. Detailed engin. underway.

TABLE 3.1 (Cont'd)

	Phase I Results	Phase I-II Transition	Phase II Activities	Phase II Results	Project Readiness for Implementation
Provo, Utah	Completion: Oct. 1982 Focus on city power plant as heat source -- need to install cogen. equipment; refuse may be feasible as a heat source, but economics highly dependent on price of elec. Hospital, BYU, & high school likely prime users. Financing & pricing obstacles remain -- particularly financing $51-93M system.	ANL study-accepted financial & price escalation rates, but varied engineering assumptions; focus on heat-driven rather than elec.-driven system. Result: staged DHC cogen. system serving UVH & PHS, initially at $2M -- new equipment & customers added later.	Start: early 1983 Detailed engineering, financial, market analysis of a small early-start project. Focus on cogen. from city power plant.	Mid-1984 Built small-scale medium-temp. HW DHC system, retrofitting one power plant coal boiler for continuous DHC system use. Explored feasibility of waste-to-energy. Conclusion: not economically attractive as a public project. Decided to build small-scale cogen. system @ approx. $1.5M.	May 1984 Through refinancing old high-interest debt at low interest, $2.3M were made available for covering the $1.5M DHC cost. Provo City Power Board resolution to recom. that city build & operate a DHC system. City Cncl. approved Sept. 1984. Groundbreaking, April 1985; service, Fall 1985.
Springfield, Massachusetts	Completion: Late 1982 Proposed 10-yr phased growth -- initially using high-temp gas-fired hot water boilers in city hall then adding solid waste energy recovery (cogen.) facility. Finally West Springfield generating station owned by Northeast Utilities. Service area includes downtown development area, mainly comm'l, industrial, & inst. uses. Initial cost $5.7M; total 10-yr cost $21.2M.	Continuing efforts to interest a private developer in building, owning, & operating a DHC system. Owner/operator of waste-to-energy facility (SWERF) not interested.	Start: Sept. 1983 Detailed analysis, design & system phasing & heavy concentration on marketing & preparing RFP for a pvt. developer. Efforts to mkt. DHC to developer of large multipurpose center unsuccessful. City staff preoccupied with SWERF financial & legal issues.	June 1985 RFP issued June 1985. Major result: designation of Energy Networks, Hartford, as preferred developer of city's DHC system -- Sept. 1985.	Negotiations underway with private developer to build, run, operate system. Financial pkging in progress & mkting to customers continuing with help from Springfield Central.

Of the six HUD/DOE-supported cities, in only one, Lawrence, did the end of work in Phase I proceed immediately to Phase II. With the great success achieved by the end of Phase I, the city was readily able to identify expansion potentials and obtain the federal matching funds to do the analysis.

In the other five, however, important changes in the Phase II proposals occurred, sometimes to the extent of dramatically altering basic concepts. In Baltimore, the barely-functioning heating system in Cherry Hill Homes was replaced by the Housing Authority with an upgraded campus-type district heating system, one which could later accept connection to the expanding downtown system. The expected heat supplier, Baltimore Refuse Energy System Company (BRESCO), installed an extraction turbine at its Southwest Resource Recovery Facility which could provide the needed thermal energy. Thus, the major issue of Phase II was developing a transmission system, or so it appeared.

Failing to receive federal funds in the first Phase II round, about a year passed before Lewiston received the additional federal support. Economic conditions had changed such that several prospective customers lost interest, but not much work had been done by the city on the project. Moreover, failure of the city and HUD to see eye-to-eye on the Phase II work plan prevented actual work from being done for an additional nine months.

No significant changes occurred in New York except the key decision to concentrate Phase II work on district heating/cogeneration at the Brooklyn Navy Yard, one of the three sites found feasible at the conclusion of Phase I.

The project selected by Provo for in-depth study in Phase II used the same heat source as found in Phase I, but with a significantly different service area. The Phase I results were uncertain, at best. The proposed system involved retrofitting the Provo City Municipal Power Plant to cogenerate heat to serve Brigham Young University and several nearby public buildings. The economics of the system were barely favorable because the BYU system was relatively new, efficient, and operated at low cost, and the total system would cost over $50 million, questionable for a city of Provo's size. In the meantime, Argonne National Laboratory was continuing to work with Provo and its consultants to provide the city with technical assistance under DOE's auspices. Using its District Heating Strategy Model and other analytical tools, Argonne researchers found that a smaller initial system, using the power plant as the source but excluding BYU, could be economically justified and within the city's means. It was this smaller project that the Provo developed in Phase II and eventually built, with only small modifications.

In Springfield change was not so dramatic. That city used the transition period to continue its efforts to find a private developer willing to build, own, and operate a system following the broad concepts outlined in the Phase I report. That effort was to continue to be the focus of work throughout Phase II.

3.1.2 Preparing the Work Plan

The Cooperative Agreement between HUD and the cities provided for a HUD contribution of up to one-third the cost of Phase II. The total cost of the work, performed by consultants in every case, was between about $150,000 and $300,000. These figures. however, are not precise. The money was spent to carry out the work spelled out in the Agreement, but most of the cities spent additional funds for related work, particularly that involved in negotiating agreements with heat suppliers or customers and, in the case of Lewiston, in the considerable effort to convince the state Public Service Commission to lower the avoided cost price for electric power that would make the DHC system feasible.

Some cities ran into conflicts with their subcontracting engineers, and occasionally with HUD over the appropriate levels of effort to spend on engineering analysis and detail and on other aspects vital to securing a project, such as marketing, financing, establishing the institutional groundwork, and related issues. This distinction is partly reflected by the time lag between selection by HUD of some of the cities for funding support and when they actually began work, i.e., hired consultants. In at least two instances, Lewiston and Lawrence, months elapsed, occupied by negotiations over balance of the disciplines to be retained and their work plan tasks and schedule. The cities differed; Lawrence wanted to end its Phase II work without reaching closure by the City Council on DHC ownership and funding configurations. Lewiston delayed mainly to complete its parallel work on a hydroelectric project.

Compromise eventually resulted, but not without some rancor and delay.

Delay at the beginning led to extensions later. It became harder, as oil prices dropped, to get closure. HUD came to liberally grant the cities no-cost extensions of the work. This allowed HUD to retain a formal relationship with the cities to maintain two-way communication as it held the cities to terms of their agreements. As it was, completion of the cooperative agreement period in no case signaled the actual end of Phase II work. It was viewed by most project directors as one more benchmark, albeit an important one, along the extended path from conception to hoped-for construction and operations. HUD's involvement focused on information transfer and network support.

3.2 LOCAL LEADERSHIP AND SUPPORT

Older district heating systems remain in many cities. Few of the privately-held ones are expanding; some are being discontinued or are being sold. In recent years, a few companies have emerged that see the potential for profit in district heating and have been buying and rebuilding systems. Many cities, including most of those discussed here, have always intended that their new systems would be owned and operated as for-profit ventures or as some type of public/private partnership.

Yet the development process, for the most part, has been a public -- government-led -- process. Although the original Phase I RFP permitted private responses, all had to demonstrate government support. In fact, all 28 applicants selected were local governments (including one American Indian tribe), as were all six in Phase II. The Columbus and Holland projects, even without federal support, also were government run. The idea in most cities would be to conduct the studies that would demonstrate project feasibility and then work to interest a private developer in building and running the system as a regulated or unregulated utility.

The Phase I Cooperative Agreements required establishment of a broad-based Assessment Work Group (AWG), carried over to Phase II. The AWG in its various conceptions has been the participatory vehicle, but much of the decision making has occurred outside the AWG umbrella.

3.2.1 Key Participants

The cities exhibit little uniformity in the nature and type of participation in the district heating planning process and there are clear factors to explain why. The following is a list of those individuals or groups that played major roles in each city's development process, followed by a discussion of some of the more interesting findings.

Baltimore

- City of Baltimore: Manager of Phase II Cooperative Agreement (Planning Department); thermal energy broker; gave Thermal Resources of Baltimore expanded DHC franchise.

- AWG: Business, industry, government, citizen groups. Little Phase II activity.

- Housing Authority of Baltimore City (HABC): 1,600 units in Cherry Hill (steam DH system), 4,000 units in Hopkins/E. Baltimore. Always considered an anchor customer; hard negotiator for thermal energy price.

- Baltimore Gas and Electric Co.: Owner of downtown DH system. Sold to Thermal Resources of Baltimore.

- Thermal Resources of Baltimore (Youngstown Thermal affiliate): New owners of BG & E system. willing operator, marketer.

- Northeast Maryland Waste Disposal Authority (NMWDA): Owner, operator of waste disposal facilities. Contracted to build 2,250 ton-per-day resource recovery facility; willing to consider supplying heat to DH. Took lead from city in Phase II.

- Baltimore RESCO (subsidiary of Signal RESCO): Full-service contractor to build, own, and operate resource recovery facility, but little interest in DH, especially marketing and retail sales.

- Resource Development Associates: Prime DHC consultants in Phase I and Phase II replacing others used earlier. Involved in all phases of conception, design, financing, and marketing.

Columbus

- City government: Initial mayor a DHC champion; current mayor supportive but less enthusiastic. Department of Energy and Telecommunications: project manager, but mostly staff role.

- AWG: Phase I, 50 members, cross-section of community interests. Minimal activity in Phase II as city chose to use a small steering group.

- Danish Ministry of Energy: Funded Phase II to test application of European DHC technology.

- Utilities: On AWG, but little demonstrated interest in DHC.

- HML Engineering: Danish consultants hired by Danish Ministry of Energy. Little direct city contact.

Holland

- Board of Public Works: Project leader. Runs city power system and authorized to construct and operate "public heating" systems. Complete project control and funding.

- AWG: Broad base in Phase I. Discontinued in Phase II.

- Hope College: Maintained public support. Contributed $10,000 for retrofit study.

- Other customers: Kept informed; supplied data.

Lawrence

- City government: Mayor LeFebre prime mover of Phase I. Two mayors since, one little interested in DHC, current mayor more supportive. Community Development Department: Always project leader and catalyst, but staff changes slowed progress.
- Refuse Fuels, Inc.: Private owner/operator of resource recovery facility; supportive of DHC; built and marketed first steam line; key to DHC progress.
- AWG: Active in Phase I; dormant in Phase II.
- HUD: Pushed work plan, schedule, active marketing, especially in Arlington Neighborhood. Interceded with mayors and city officials when activity slowed.
- HDR: Consultants to both city on DHC and RFI on resource recovery. Several subcontractors.
- Neighborhood Housing Services: Hoped-for sponsor of Arlington Neighborhood DHC ownership/marketing entity.

Lewiston

- Planning Department: Project manager throughout. Provided leadership and continuity.
- City administrator: DHC supporter; became enthusiastic after visit to Sweden.
- AWG: Typical cross-section in Phase I. In Phase II, limited to customers who had contributed to study; actively involved in project policies.
- Maine Department of Environmental Protection: Provided half the city's local matching funds for special study of environmental aspects of landfill, ash disposal, and air pollution, all critical Maine issues.
- Maine Public Utilities Commission: Its decisions on avoided costs of electricity from small power producers critical to DHC project feasibility.
- Central Maine Power: Not a direct participant, but a "gray eminence" whose power purchase requirements affected study decisions.
- Consultants: Metcalf and Eddy used in both Phases I and II; considerable effort to optimize a system to meet electric power requirements and supply district heat. Local engineering consultant used as technical liaison between city and prime contractor, providing important insights throughout.

New York

- Brooklyn Navy Yard Development Corp.: Manages BNY industrial park; provides energy services; seeking lowest energy costs possible.

- NYC Department of General Services: BNY "landlord," BNYDC lessor. Chair of Interagency Cogeneration Task Force (ICTF). Contractor for energy supplier to public housing.

- NYC Energy Office: HUD project leader; technical project oversight including hiring of consultants.

- NYC Housing Authority: Key prospective customer maintained pressure on city to supply district heat to heating system serving 5,000 housing units that would have required extensive modernization.

- ICTF: Replaced AWG for Phase II. Included all key city actors; met irregularly to monitor work, select private developer/operator; fluid membership; unclear authority.

- Brooklyn Borough President: Concerned about rising costs to BNY tenants, ordered more studies that led to final decisions to proceed.

- Consolidated Edison: Electricity and steam supplier not a direct participant but played important indirect role in determining competitive energy prices.

- Montenay Corp.: Won competition (in association with Brooklyn Union Gas) to be designated system developer. U.S. subsidiary of French company.

- HUD: Important direct and indirect role in moving work forward; pressured city to consider BNY/public housing link with DHC; encouraged application for UDAG.

- Many others played behind the scenes roles, particularly Deputy Mayor and other top city officials.

Provo

- Mayor: Provided hands-on leadership critical to project progress.

- Planning Department: HUD contractor, project manager from project inception.

- Provo City Power: Municipal utility; active technical role in analyzing power plant as heat source.

- AWG: Broad base in Phase I narrowed in Phase II but included city departments, Provo City Power, end users, financial community. Chaired by Mayor. Important policy role.

- Consultants: Original Phase II consultant replaced later with RDA, more experienced in small-scale DHC; provided engineering as well as financial/institutional services.

Springfield

- Mayor: Original mayor supportive, but became enthusiastic about DHC after visit to nearby Hartford system.

- City Department of Public Works: Project leader. Maintained continuity throughout. Developed waste-to-energy facility for the city.

- Springfield Central: Downtown business development group actively pushed DHC; provided direct marketing services.

- AWG: Became Project Steering Committee in Phase II; smaller and more focused.

- Energy Networks, Inc.: Hartford-based firm designated as Springfield DHC system developer.

3.2.2 Findings

This list of project participants and their roles leads to some interesting and instructive findings:

1. Role of the mayor. With local government taking the lead in conceptualizing and designing DHC projects, strong mayoral support can be a key to moving a project forward. In cities like Provo, Lawrence, and Springfield, mayors took active roles providing direction to staff, promoting the concept among other public agencies and the private sector, and joining in national DHC efforts with HUD and the U.S. Conference of Mayors. Private developers often credit hands-on mayoral leadership with significantly contributing to project success. But mayors come and go, and have different interests and priorities. In one or two instances here, projects have proceeded through three administrations with very different levels of interest in DHC. Where others such as staff or an outside group have picked up the ball and served as project "champions," some semblance of continuity has been maintained. Elsewhere, the process has been rocky at best.

2. Role of staff and others. Projects take a long time from concept to operations. Surprisingly, three of the eight cities have had the same senior staff throughout, and three others maintained staff leadership from Phase I largely through the end of Phase II. This continuity has helped maintain local interest, and has, at least, built local capacity to understand the complexities involved in DHC system development. Continuity has also come from other

sources, the most notable of which is in Springfield where Springfield Central has played a key role in marketing DHC to the downtown business community that it represents.

3. Role of the AWG. Assessment work groups were broad-based and active in Phase I, at HUD's insistence. HUD imposed fewer participatory requirements in Phase II and cities chose different approaches. Most dropped the concept of the AWG, choosing instead to use a smaller policy group consisting of those with a direct stake in the outcome such as heat suppliers and probable customers. This was the case in Lewiston and Springfield. Others attempted to maintain the community-based AWG as in Baltimore, Columbus, and Provo, but the degree to which these contributed to project policy-making is not clear. Lawrence, New York, and Holland relied almost exclusively on city staff and consultants to provide policy direction. In New York, the Interagency Cogeneration Task Force was a fluid group where various interests came together irregularly to hash out, and sometimes resolve problems. On the the other hand, the effort to try to resolve often- conflicting project objectives often enabled the ICTF to lose focus, and delay decision pending completion of more work that would, presumably, satisfy the most recent concern raised.

   In Phase I, the aim is to identify one or more feasible projects. The process involves public DHC education as much as study, and broad participation can be very beneficial. The role of the AWG in Phase II is less clear; in the cities discussed here, at least, the breadth of participation seemed less important than targeted participation by those standing to be directly affected by the project. In the final analysis, however, success of a project can be helped by strong backing but whether a project goes ahead or not is fundamentally an economic decision.

4. Role of consultants. Every Phase II city relied on consultants for the technical work. Most were pleased with the work. Some were not and changed their consultants. Not every large engineering firm is skilled in the subtleties of district heating plant and distribution system design, and several cities went through a systematic RFP process to select those with experience appropriate to their needs, e.g., small-scale cogeneration, waste-to-energy systems, hybrid plant design. At least two cities learned painfully that past power plant design experience was not necessarily an assurance that a consultant would meet their needs. Several used multiple consultants, either directly or as subcontractors to the prime consultant to perform such special studies as residential building retrofit, use of refuse as a fuel, and legal and financial analyses. Lewiston hired a local consulting engineer to serve as the city's liaison to the prime consultant, an approach the city and lay members of the AWG found to be very helpful. Finally, Columbus represents almost a classic case of a community being presented with a study in which it had had little involvement, and hence little stake, and which, so far, has not produced a project (A later study, however, with more city involvement, seems to be making more progress toward implementation).

5. HUD role. HUD provided up to one-third of the funding for each of the Phase II studies. With the legal arrangement a cooperative agreement rather than a grant or contract, HUD staff cooperated with the cities in an active way, provided technical assistance, advice, and in several instances, exerted pressure on local staff or mayors to take action when progress seemed stalled. HUD's share of the funding, in effect, gave it an entre into the study process that allowed it to keep its hand actively involved as sort of a silent partner in the deliberations. It made a continuing effort in several cities such as New York, Baltimore, and Lawrence to keep a focus on public housing as an anchor customer. It insisted on systematic work planning, sometimes to the displeasure of local officials. Energy Division staff encouraged local officials to consider all available federal funds for system construction including UDAGs and Community Development Block Grants. And its annual conferences in Washington helped cities showcase their work, share information, and generally to maintain enthusiasm, particularly among the cities' mayors. In at least one case, Holland, the HUD requirements were deemed unacceptable to the city in exchange for its one-third funding, and the city opted to proceed on its own (but cooperated by providing information for this analysis).

   Overall, it is fair to say that, at least in some cities, HUD staff played an important role in maintaining progress; despite some strains, a more laissez faire attitude might have led to fewer successes.

6. State government role. State governments generally had little active role in these studies. The notable exception is Lewiston where the state Department of Environmental Protection provided half the city's HUD match because of the city's critical landfill situation. This funding allowed for in-depth analysis of prospects for a refuse-to-energy system as well as studies of air pollution and ash disposal. State activity in other Phase II studies included: rulings by public utility commissions in Maryland and New York that district heating thermal service need not be subject to utility regulation under certain conditions; agreement by Massachusetts to provide residential weatherization funds to significantly lower thermal energy demands in Lawrence's Arlington Neighborhood; agreement by the state of Utah to provide funds for retrofitting the hospital; preliminary agreement by the State of Ohio to receive district heat from a Columbus system; and agreement by the New York State Job Development Authority to provide $3.5 million to help finance the project.

Many interests have been represented in the process of conducting these studies, varying substantially to fit community needs. The projects that proceeded most smoothly were those in which goals were accepted and shared by all participants, where leadership was strong and continuous, and where those who had a direct stake in the outcome were partners in the process.

3.3 CONCLUSIONS

One interesting observation about the Phase II process is that it was unpredictable and took much longer than expected. Each of the cities chose the system configuration deemed most feasible at the conclusion of Phase I (as modified in the transition period) and subjected it to a series of engineering, economic, and environmental tests, optimizing the variables to determine the most financeable project. The technical studies could be programmed in advance and consultant contracts awarded to do the work.

But there is far more to getting a DHC system built than performing technical studies. Most cities have little interest in developing and operating DHC systems, unless they also run municipal electric utilities. Their aim is to design a package sufficient to warrant serious consideration by a private investor. Thus, while this avoids the complex process of bringing a public project to fruition and minimizes city risk, it also introduces a number of other factors into the process that can rarely be controlled, much less scheduled.

As expected, the bulk of the effort expended in Phase II has probably been spent not on studying but on financial packaging and negotiating. Particularly where work centered on attracting a private firm, as in Lewiston, New York, Lawrence, and Springfield, the "product" was seen not as a report but an RFP for an owner/operator. Preparation of this document and selection of a contractor often precipitated a series of extensive negotiations over nature of service, cost sharing, financial layering, profit sharing, and related, matters that consumed months or, in the case of New York, years.

In certain cities, in addition, negotiations centered on getting anchor customers to sign long-term thermal energy purchase contracts. In Baltimore and New York, large public housing complexes were key parties, with negotiations concluding successfully in New York and unsuccessfully, at least for now, in Baltimore. In Lawrence, city staff and consultants spent considerable time drafting and redrafting steam purchase agreements to try to match steadily falling oil prices, and ultimately got 300+ units of public housing connected to the system.

In the final analysis, then, the nature of the product must be the determinant of the process. A publicly-developed and operated system can be treated like other major public improvements, albeit often with much more complexity, and with the focus on preparing a package saleable on the revenue bond market (if that is the chosen financing approach). But in the more common case of trying to attract a private full-service operator, the product can be a more generalized prospectus or RFP with the anticipation that its completion is only one important step in a long process.

4 EXTERNAL CONSIDERATIONS

Planning a district heating system is not done in a vacuum. Factors which may be totally outside the means of planners to control may exercise constraints on what can be done at a given time. Alternatively, some conditions can open up opportunities that might otherwise not be available. These may include a wide range of economic, regulatory, political, and institutional factors. While significant variations exist from place to place, there are also many factors in common.

It can be argued that with lowered oil prices the prospects for successful DHC investment becomes the exception. The long-term promise in the view of most who watch energy pricing appears to favor DHC investment. What follows is not intended as a deterrent to those contemplating DHC development, but to alert such parties to some of the hazards along the way, as well as to offer some help in deciding on a DHC investment. Clearly, the eighties have not been favorable toward DHC, yet despite the obstacles, new systems have been created and old ones purchased and upgraded.

The case studies identified a large number of important considerations. Selected factors are briefly summarized here. Some of these, while identified in individual case studies, clearly have general applicability.

Baltimore

- Although uninterested in operating a DHC system, the Northeast Maryland Waste Disposal Authority was interested in adding flexibility to its revenue stream. It therefore added steam extraction to its turbine at the Southwest Resource Recovery Facility even before an attractive economic market was apparent. This later gave Youngstown Thermal a strong incentive to purchase the downtown system.

- The specific plant design at the Facility enables steam to be extracted from the system at two points, depending on system load, while simultaneously producing electricity. This offers maximum flexibility to serve both thermal and electrical demands.

- On the other hand, a lower than expected waste stream (a major competitive MSW use was introduced) has had a dampening effect on the ability to provide thermal energy to the DHC system, and potentially to open up other thermal energy markets.

- The owner of the Southwest Facility, BRESCO, is a subsidiary of Signal-Resco, a $7 billion corporation. Its interest was in the success of the Facility; a relatively small DHC system, would have little effect on its revenues. Thus, while a cooperative partner in exploring markets for its waste-to-energy facility, BRESCO could not be considered an aggressive developer of DHC systems.

- Public housing has become a major customer for an entirely unforseen network now coming on line. For the initial public housing customers base network, however, an important potential constraint remains the limited ability of local public housing agencies to reap direct benefits from fuel cost savings because of HUD utility compensation regulation (see below), thereby dampening prospects for connecting the potentially best customer to the new system. Savings now go back to HUD which underwrites fuel costs nationally for public housing. PHAs, however, find savings in maintenance, heating plant salaries, and service reliability. Conversion from steam to hot water have shown marked tenant approval in some recent instances.

Columbus

- Columbus' most likely heat source, the MSW-fired plant, was undergoing serious cost overruns. It was also several miles from significant downtown loads. Operators had little interest in pursuing DHC as an energy market; DHC planners were similarly concerned about saddling district heating with the incinerator's financial problems. This appears to be resolvable, however, as both parties near agreement.

- Columbus enjoyed large sums made available for feasibility analyses, but weak public and private leadership patterns may have inhabited positive outcomes for the city's several promising designs.

- Initial focus on MSW plant delayed examination of heat sources closer to concentration of users.

Holland

- The natural gas utility would be expected to aggressively challenge the DHC system to retain its gas customers. In fact, it did offer lower prices when Holland's financial analysis showed it could save potential customers 15-20 percent.

- One of the system's most desirable potential customers is owned by a large national corporation headquartered elsewhere. The local management showed little interest in dealing with DHC issues and has required the city to deal more directly with out-of-state managers.

Lawrence

- Falling oil prices have fatally undercut customer interest in purchasing thermal energy from a DHC system.

- The power plant owner obtained a significantly higher price for his electricity from a more distant utility, lessening his interest in marketing thermal energy.

- Federal tax reform legislation, first in 1984 then in 1986, created a climate of uncertainty among prospective DHC investors.

- Due to apparent deficiencies in valving design and performance, the new steam line never worked properly. Litigation was threatened between the system owner, the pipe manufacturer designers, and installers. Potential new customers were uneasy, at best, about signing on until all technical problems had been resolved.

Lewiston

- The city's study of DHC to serve downtown industry has opened up prospects for service to outlying industry, as well.

- A need to find a long-term replacement for a landfill rapidly nearing capacity focused project planning on use of MSW as a fuel, particularly with the state DEP funding half the city's HUD match for development preparations.

- Volatile fuel prices, particularly for oil and wood, made economic forecasting extremely uncertain. Several wood-fired boiler investors came forward during this period, ending in a high proportion of failures as oil prices declined.

- Most important, the avoided cost rate for electricity to be purchased by Central Maine Power Co. was the ultimate determinant of project feasibility in this electrically-driven project. The state's PUC greatly diminished the payback rate with each successive request for applications for cogeneration.

New York

- The Tax Reform Act of 1984 created a climate of uncertainty about the use of Industrial Revenue Bonds for cogeneration project financing.

- Consolidated Edison Co., competing for electricity and possibly district heating customers, provided the baseline against which prices for energy from other sources had to compete. In fact, when the price for new system was established, Con Ed was asked to meet or beat it, but couldn't.

- The New York City Housing Authority was also constrained by federal regulations (like Baltimore) not only as to who would retain the benefits of lower energy prices, but also in the kind of contract it could sign.

- Once in place, this system has rapidly attracted new customers in major distribution spurs to follow.

Provo

- The U.S. EPA may eventually require BYU to install flue gas desulfurization system to meet emission standards. It may be cheaper to connect with the DHC system.

- Need for waste volume reduction to extend landfill life may eventually make MSW a viable DHC fuel.

- Although Provo City Power has an investment in an outside power plant, it has found that its own plant could be run more cheaply. This has enabled the Provo plant to cogenerate thermal energy for the DHC system.

- Natural gas prices are expected to escalate rapidly, thereby making coal-fired cogeneration more attractive.

- The city's study area for its stage one proved unattractive to its developer. But experience there paved the way for a rapid creation of a larger, adjoining configuration, fully understood and accepted by the key parties.

Springfield

- Interest in tieing the DHC system in with the new waste-to-energy facility so as to help defray its carrying costs, led the city to stage the initial DHC project and tie waste heat in later as it comes on line.

A review of these factors indicates that the most potent system influences are:

1. Prices of competing fuels: This, of course, is the fundamental economic issue. Unless district heating can beat the competition, typically defined as 15-20 percent below, most customers are not inclined toward in making the conversion to DHC technology. In the short term, this factor has delayed implementation of many projects; in the long term, competing fuel prices may rise to a point where DHC becomes increasingly attractive.

2. Avoided cost of electricity: For cogeneration systems, particularly those like Lewiston which are electricity-dependent, the price of electricity virtually determines feasibility.

3. Local leadership: This is nonquantifiable, but a change of mayors or shifts in other local leadership can determine project momentum and lead to a gain or loss of critical local consensus.

4. System momentum. Once a DHC study agenda has seriously gotten underway it often proves to be the pivotal ingredient when a configuration, of whatever size and shape and in its own time, comes into focus and a diversity of decisions must be blended.

The effects of economic factors that may hinder project development, such as costs of competing fuels and avoided costs of electricity, may be diminished by the concurrent reduction in the cost of money, often resulting from the same national or international considerations. Similarly, but on a smaller scale, higher tipping fees for municipal waste may provide an important revenue source for MSW-fired systems that may also help to make some systems economical.

These factors, singly or in combination, can be the major reasons why DHC projects may succeed or fail.

5 PROJECT CHARACTERISTICS

Since the focus of this report is on the project development process, no attempt is made here to discuss in detail the specific engineering design and economic characteristics of each of the projects. The final configurations, whether just in report form or actually underway, are necessarily city- and project-specific and only a few generalizations can be made instructive to other cities. Instead, we will present some observations and cautions about these issues based on the experiences of the eight cities that planners and designers may find useful.

5.1 SYSTEM OPTIMIZATION

Many of those involved in district heating are fond of saying that district heating engineering is no more than a big plumbing problem. Technologies, it is argued, are largely proven. Decisions need to be made for example, about distribution fluids and temperatures, but these are often constrained by the character of an existing heat- only or electric power generating plant to be retrofitted for cogeneration, in combination with customer requirements. Hybrid systems often are the choice where both manufacturing (or hospital needs) and space heating is involved. Adaptation to local conditions requires experience, skill, and creativity in designing optimum systems that balance thermal and electric output needs with flexibility to meet customer demands and system revenue needs.

This optimization process may be the crux of project design especially where seriously constrained by external factors.

Lewiston may represent a prototypical example. The study effort was initiated to serve a single objective, lower energy costs to older mill structures in order to improve their economic position. In Phase II, this objective was extended to a serious look at use of municipal solid waste as a fuel, because of a near-critical refuse disposal problem. The lack of an available preexisting heat source meant a new plant would need to be built, but the heat load was insufficient to generate adequate revenues to meet debt service requirements. Thus, project focus moved to a a dependence on the sale of electricity, with revenues from thermal energy sales almost incidental.

With this focus clearly in mind, economic viability of the project became dependent on the price established based on the avoided cost of producing electricity to be paid by Central Maine Power Co. under authority of the Maine Public Utilities Commission. Project designers spent many months optimizing system costs and revenues by modifying fuel mixes and costs, refuse tipping fees, thermal/electricity production, and other factors, in an effort to meet CMP's avoided cost, time of day, and other requirements. The efforts did not succeed. Avoided cost rates have continued to decline making the system uneconomic, at least until prices rise.

Other cities have faced similar prospects, including Baltimore, which was on the verge of failure until Catalyst Thermal bought the downtown DHC system and tied it in with the new waste-to-energy plant; and New York, where system optimization to meet the steam and electric needs of BNY tenants, steam needs of 5,000 units of public housing, and revenue requirements of the owner/operator had to be balanced.

The Lawrence experience suggests, too, that a well-planned and designed system can be financed and built, but that considerable care must be taken in writing explicit specifications and bonding their performance. The pipeline part of that system has not worked up to design standards since it was built. This failure has damaged prospects for district heating in that city.

5.2 COGENERATION

All of the eight cities here have chosen cogeneration rather than heat-only central plant designs. These cities are not a random sample, but the uniformity of this approach strongly reenforces accepted notions that cogeneration is the usually preferred design approach. Each of the cities had specific reasons for choosing cogeneration; other cities might find these reasons instructive where circumstances are similar.

All but one of the cities in this selection had preexisting or under-construction electric generating plants that would serve as the district heating system's thermal energy source. In Baltimore, the source is BRESCO's waste-to-energy incinerator. In Holland and Provo, the source is the municipal power plant, in both cases located immediately adjacent to downtown. In Lawrence, the proposed system would use heat from a newly-built resource recovery facility. And in Springfield, district heat would be served by a refurbished City Hall boiler with excess capacity, but the resource recovery facility across the river would be tied in later to provide thermal energy for an enlarged system. The Columbus system is planned to be served by the recently-completed refuse and coal-fired municipal power plant. And district heat in New York's Brooklyn Navy Yard project would be provided by drawing heat off turbine generators in the Yard.

Only Lewiston proposes to build an entirely new plant. There, as noted above, district heating remains the primary basis for building the plant, but this objective can only be accomplished through a system design in which most of the revenues would be derived from selling electricity back to the utility. The dependence on electricity sales to drive the system, however, makes project feasibility almost totally dependent on the price of electricity.

The lessons here are:

1. Cogeneration allows the owner of the plant flexibility in responding to the market, balancing thermal and electrical energy sales to respond to price. This flexibility, of course, is limited by long-term purchase agreements from customers of both electricity and thermal energy.

2. Cogeneration increases the efficiency of the power plant, from a low of about one-third to as high as 80 percent; heat that is now wasted can be sold to the benefit of both the plant owner and thermal and electricity customers.

3. Cogeneration also allows seasonal variation of output, particularly beneficial for summer peaking electric utilities.

4. Where an existing power plant is to serve as the heat source, central plant construction costs are minimized.

These lessons are derived from the specific experiences of these cities. Certainly there are examples elsewhere of heat-only district heating systems and these should be considered where appropriate.

5.3 BUILDING CONSERVATION AND WEATHERIZATION

District heating system designers and developers usually base load requirements on current building conditions. Failure to consider weatherization and other upgrading opportunities can negatively affect system revenues should such measures later be installed by owners. On the other hand, construction of a district heating system, can offer an opportunity to upgrade building energy conditions, concurrent with retrofit actions when connecting to the system.

Two of the cities here seriously considered building conservation, and one has taken action. In Provo, the prime consultant conducted energy audits of the anticipated anchor customer buildings and recommended specific measures to reduce energy consumption. As eligible institutions, the schools and hospital applied for and received funds from the State under DOE's Schools and Hospital Program, and significantly improved their energy use characteristics. As a result, they benefitted doubly from district heating, lowering their unit costs and their total consumption.

Lawrence was one of only two participating cities looking directly to serve a residential neighborhood with district heating. Weatherization of the older frame mostly three-story structures that form the bulk of Arlington Neighborhood residences was built into project financing, with the intent of using CDBG funds for financial assistance. Residents, both owners and renters, would pay about the same as before during the near term, but with upgraded buildings and long-term heating reliability.

Initial load estimates in the Baltimore study were largely based on leaky buildings, low boiler efficiencies, and other non-energy-efficient characteristics. System designers assumed that loads would be reduced by an unspecified amount through building improvements, which the new DHC system owner is considering.

5.4 USE OF REFUSE FOR FUEL

Solid waste disposal is a serious problem in cities throughout the U.S. In a large number of the original 28 Phase I cities, the prospects for burning waste to fuel a district heating system, or the existence or expected construction of a waste-to-energy plant, served as the impetus for the study. It is fair to say that in more than one city, the project was driven more by a need to deal immediately with a landfill capacity problem rather than by a desire to build a district heating system. The potential to marry the two concepts served to heighten local interest.

These eight are a good representation of such cities. Baltimore, Lawrence, Columbus, and Springfield all have plants operating locally to convert municipal solid waste (MSW) into electricity. In two of them, Baltimore and Lawrence, retrofitting the power plant to generate thermal energy as well as electricity presented no significant technical or economic obstacles (problems in Lawrence are not with the plant). In Columbus, the most likely heat for DHC is the new waste-to-energy facility, but concern over saddling district heating with the financial problems of that facility has made designers somewhat leary of the linkage. The Springfield system presented no such concern. The operators of that plant, as in Baltimore, are in the waste-to-energy business and have no interest in branching into the direct provision of district heating service. Both, however, are willing to wholesale thermal energy to a district heating operator to improve their revenues and help balance cash flows.

Provo did a separate detailed study of generating thermal energy from burning MSW. Its present landfill was to have closed in 1986, replaced with one 33 miles away using an in-city transfer station. The economics of this system served as a base case for comparison with using MSW as a fuel, but the study projected that a new facility would have an operating deficit of $330,000 per year, or $5.50 per ton. Thus, trash-fired cogeneration is not feasible now, but economic conditions will continue to be monitored with the possibility of its being added later.

These experiences suggest several conclusions:

1. MSW as a fuel for district heating must compete with other forms of disposal. Where tipping fees at sanitary landfills are relatively low, waste-to-energy may not be an economically attractive alternative.

2. Use of MSW as a fuel cannot be divorced from ownership and operating entities. In at least three cities, Baltimore, Lawrence, and Springfield, plant owners expressed willingness to install equipment that would add thermal output to the preexisting electrical output, but had no interest in going into the district heating utility business. Selling electricity to the power grid or wholesale heat to a district heating retailer means relating only to one or two customers, a condition with which they may be comfortable.

3. Designing a waste-to-energy plant, particularly one involving cogenerating heat and electricity, presents no insurmountable problems. Nonetheless, not all plants are operating at their design capacity. System planners should investigate the operating history of similar plants before proceeding to financing and construction.

5.5 STEAM QUALITY

A rarely-mentioned but potentially important question in designing certain district heating systems is steam quality. Providing thermal energy solely for space heating needs permits great flexibility in medium (steam or hot water), temperature, pressure, and other factors. But where thermal energy is to be used for processing, flexibility is seriously constrained. The end user usually needs steam, and often of a determined quality. This is particularly the case with hospitals which often use large quantities of steam for laundry and for sterilizing medical equipment.

Hospitals are highly desirable customers for a DHC system because their loads are high and, because of processing needs, relatively constant. System designers have found, however, that hospital officials, and often manufacturers as well, insist on assurances of complete separation of the steam created in the plant, and that which they use in their operations. This can be done at the plant through the use of reboilers (evaporators) which use high pressure steam to generator lower-pressure steam, as is planned for the Holland system. Alternatively, and depending on the requirements of other users, heat exchangers can be installed at the end-user side, to produce steam meeting their needs. In either case, steam quality is assured through maintenance of independent systems.

There is some loss of electric power generating capability in using reboilers as compared to the direct sendout of steam to the DHC system, but there is the important benefit of precluding contaminants from entering the system.

5.6 SYSTEM OWNERSHIP AND FINANCING

In all but two of the cities, the intent of project planners has always been to plan a project sufficiently attractive to interest a private full-service operator in building, owning, and operating the DHC system or a substantial part of it. The remaining two are Holland and Provo, both with municipal electric utilities for whom the addition of district heating at the relatively small scale initially proposed would present merely an extension of their present utility functions with no particularly difficult financing or regulatory obstacles. (Provo City Power has been able to take advantage of a novel financing scheme called "advanced refunding," in which old debt was restructured to make funds available for the new DHC project, principally by buying insurance to protect holders of existing revenue bonds, thereby freeing up debt service reserve funds to build the new DHC system. This scheme cost the city nothing. The insurance costs were covered in the refinancing.)

Four of the six remaining cities have achieved some degree of success in attracting private investment. In Baltimore, Thermal Resources of Baltimore, a subsidiary of Catalyst Thermal, has purchased the downtown district heating system from Baltimore Gas and Electric, is purchasing steam from the BRESCO waste-to-energy plant, and is exploring expansion opportunities. Although it is not yet economic to connect the Cherry Hill project Baltimore planners had been working on for years, the fact that an aggressive DHC owner and marketer is now operating in that city is a direct result of that early work and bodes well for future expansion.

New York has designated the Montenay Corp. as its Brooklyn Navy Yard cogeneration system developer, and both are expected to profit by the arrangement. The developer will gain through profits and expected tax benefits* and the city by sharing in the profits which will be invested in needed BNY capital improvements.

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*Note: Case studies were written before enactment of the 1986 Tax Reform Act.

The selection of Energy Networks of Hartford as Springfield's preferred DHC system developer capped that city's long efforts to attract a private full-service operator as an important underpinning to its downtown redevelopment efforts.

Finally, the construction of Steam Line No. 1 by Lawrence's Refuse Fuels, Inc., was another example of strong private/public cooperation. And the new system planned for construction in the Arlington Neighborhood would be owned by a new entity under the sponsorship of Neighborhood Housing Services, a respected, credible community organization.

Several observations can be made about private system ownership:

1. Full private ownership, or some form of private/public ownership arrangement, can offer opportunities to take advantage of tax benefits (but the Tax Reform Act of 1986 will change these conditions), insulate the city from certain technical and economic risks, and provide both parties with direct and indirect benefits.

2. Many cities simply don't want to get into the district heating business, especially where the marketing demands exceed their experience. A profit-sharing arrangement can provide some of the financial benefits without the risks of direct financing, construction, billing, and dealing with multiple customers.

3. Cities can assist private owners with industrial development bonds and obtaining Community Development Block Grants to help finance such projects, where appropriate.

4. In many of these cities, much of the work in Phase II was occupied with writing RFPs for private developers, conducting the solicitation, and negotiating with the designated developer. As noted earlier, the effort involved in this approach focuses attention on implementation rather than engineering/economic optimization because the designated developer will, of course, prepare its own financial statements before beginning construction.

5. Where service to a residential area is involved, a credible private owner can help overcome residents' doubt and uncertainty about the unfamiliar technology and its potential effect on energy prices.

Private ownership of all or part of a DHC system is seriously affected by tax considerations. In Provo, for example, the early-start system will be owned and operated by Provo City Power, but later expansions may be under private sponsorship. The eligibility for favorable tax treatment may have been affected by passage of the Tax Reform Act of 1986, and may vary internally by the type and use of various types of equipment. Careful analysis by competent tax attorneys can be an important determinant of ownership and financing arrangement, particularly the nature and degree of private vs. public ownership.

5.7 LINKAGE WITH EXISTING DISTRICT HEATING SYSTEMS

Analysis of the experience of the 28 Phase I cities indicated that tieing new DHC systems with existing infrastructure -- a functioning system, old but usable pipes, a retrofit boiler -- can improve project economics. Phase II results are more cautionary and location-specific.

Only Baltimore of these eight cities had a fully-operating, multiple-customer system. This system is in relatively good technical and financial shape and ripe for expansion, particularly with the purchase of thermal energy from the BRESCO plant.

Four of the cities have considered incorporating university DHC systems in broader systems. Provo, Columbus, and Baltimore dropped the Brigham Young, Ohio State, and Johns Hopkins university systems from inclusion in early-start systems. In each case, economic analysis showed that a newly-constructed system could not compete favorably with the cost of in-house thermal utility service. The scale of the existing university operations had already captured much of the benefit that a DHC system could offer. In each case, later linkage will be considered when the new systems have some operating experience.

The fourth community, Holland, has been relying on serving Hope College as an anchor customer. Strong interest by the college has diminished somewhat with analysis that showed a relatively high retrofit cost. The drop in fuel prices has made this project infeasible at the present time.

On the other hand, small, old, inefficient systems can be incorporated into new multiple-customer systems and improve system economics. Both Lawrence and Lewiston, for example, have mill complexes with central service from nearby mills. With modernizing, these could help anchor the new systems.

Finally, the focus of the New York city project has been the upgrading of the existing district heating/electrical distribution system in the Brooklyn Navy Yard industrial park. But the old system needs major upgrading to control both steam and electricity line losses, improve metering to control and fairly allocate costs, and eliminate redundancies. The studies needed to determine the costs of this work, and who should pay for them, have consumed most of the effort over the past several years.

5.8 REGULATORY ISSUES

In reviewing the 28 cities Phase I studies, the preliminary reviews of state regulations indicated that there were few or no barriers likely to be encountered, but that more detailed review would need to be done in Phase II. These Phase II results largely confirm the earlier findings. Except for a few special circumstances, state regulatory provisions did not come into play relative to these projects. A few examples illustrate issues that might be encountered.

Systems expected to be operated by municipal utilities generally should be free of state regulation. Utah cities, for example, are authorized to own and operate public utilities. While the definition is vague (particularly as to service area), DHC service seems to be legally authorized; municipal corporations are explicitly excluded from PSC jurisdiction. The same generally holds true for the Holland, Michigan, project.

Environmental factors have been at play in New York and Lewiston. In New York, the Red Hook Sewage Treatment Plant is being built within the BNY to meet court-enforced EPA water quality standards. That plant may supply methane to fuel the DHC system, and may later purchase electricity. In Lewiston, the State of Maine's stringent landfill standards has been a major impetus to moving that project forward; the designation of ash as a "special waste," and its typical tipping fee of $40-$60/ton, has also been an important factor in shaping the project, both technically and economically.

The City of New York sought and obtained a ruling from the PSC to the effect that thermal energy can be sold, without state regulation, up to one mile outside project boundaries for cogeneration systems up to 80 MW capacity.

In Baltimore, a team was formed to explore legal and institutional issues including rights of way, franchising, and state PSC regulations; evidently, no significant issues were uncovered to stand in the way of expanding the system.

Recognizing that these eight cities are not necessarily fully representative, their experience suggests that there are few regulatory issues that should pose significant obstacles to DHC systems.

6 DHC SYSTEM BENEFITS

The National District Heating and Cooling Assessment Program was initiated by HUD and DOE because of the apparent community and economic development benefits that could accrue to their sponsoring cities. Studies had indicated that cities would benefit via job retention and attraction, improved business competitiveness, and reduced housing costs. Phase I studies made efforts to project such benefits.

Actual, hard evidence that such benefits occur has been difficult to obtain, mainly because few systems have been built in recent years and, where they have, indirect benefits have been hard to quantify. (Footnote: For a good national discussion of DHC benefits and other related issues see: District Heating and Cooling Program Policy Analysis, prepared for Assistant Secretary for Community Planning and Development, U.S. Department of Housing and Urban Development, by Resource Development Associates, Inc., April 1985).

These Phase II cities appear to have given relatively little consideration to determining indirect benefits; their concern has been with configuring projects whose direct benefits, to investors and customers, would be sufficiently demonstrable that the projects would, in fact, get built. Direct benefits are considered to be: lower customer energy costs, long-term energy service reliability, investment opportunity, and externalizing the provision of thermal energy services through utility rather than self-provided systems, thereby saving internal space and labor costs.

Thus, the primary consideration seems to be to build a system, even a small one, to demonstrate the technology and the direct benefits. Indirect benefits will follow.

Community development benefits were assumed in most cities by virtue of the location of the target project in important redevelopment areas. Not only would addition of district heating lower costs, but the linkage of multiple customers via a piping system would serve as a symbolic gesture of joining the area together within a common framework.

The Lawrence project grew directly from an energy/economic development strategy developed years earlier by the New England Innovation Group that saw high energy prices as a serious detriment to the city's future development and district heating, among other measures, as an important cost saving measure. In New York, the Brooklyn Navy Yard is the centerpiece of the hoped-for revival of the Bedford-Stuyvesant and surrounding neighborhoods, but the highest energy prices in the country prevented the Park from competing effectively for new businesses. And the Springfield system has been seen by both city leaders and the downtown business group, Springfield Central, as an important way to further its successful development program.

6.1 DISTRICT HEATING AND PUBLIC HOUSING

Public housing can be an important district heating anchor customer and, as such, has received a lot of attention in such cities as Baltimore and New York. In Lawrence, two of the first three customers on the system were small public housing authority complexes.

While desirable, the public housing connection presents certain obstacles resulting from federal regulations. Attempting to overcome these issues occupied a great deal of attention by project planners in Baltimore and New York.

The Housing Authority of Baltimore City (HABC) was viewed as the predominant potential anchor customer because of the extensive high density public housing located in both the Cherry Hill and Hopkins-East Baltimore Areas. The HABC was a considered a particularly attractive client because it clearly had the capacity to enter into a long-term contract and because it represented a sizable enough thermal load to "anchor" a system. Further, there were both structural as well as economic reasons why district heating was attractive to HABC. Not only did DHC hold open the promise of lower cost energy, with a lower rate of fuel cost escalation, but it also promised to simplify staffing problems. As a government agency, HABC was constrained in the salaries it was able to pay for engineering, operating and maintenance engineers, and thus had historically experienced difficulty in adequately staffing its heating plants. The district heating system, by delivering thermal energy directly to the site, greatly reduces the need for skilled operating and maintenance staff, solving a continuing personnel problem.

For these reasons, the HABC enthusiastically endorsed the concept of DHC if it could provide additional flexibility in energy supply at current and future competitive prices with conventional oil or natural gas. The main questions for the project then were: (1) who would the DHC developer be, and (2) what purchase agreements could be negotiated between the developer and the HABC that could be sufficiently beneficial to construct a system.

An important issue arose as the project proceeded. Current HUD cost-allocation rules provide that housing authorities are reimbursed dollar-for-dollar for rate increases and receive less, dollar-for-dollar, for rate decreases. Thus, local housing authorities do not derive direct financial gains from switching from higher-cost fuels to a lower-cost fuel, in this case from oil to natural gas or MSW. Also, under the same rules, even though less energy will be used with the new system, dollar savings for reduced energy use are shared with HUD. Attempts were made during the planning period to make exception to these rules for hookup to district heating systems, but without success.

With its Cherry Hill Project heating system in imminent danger of failure, the HABC had to install a new system. Its original plans had been to install individual gas-fired boilers; instead, it received $7.3 million in HUD modernization funds to renovate the Cherry Hill system as a campus-type district heating system to be compatible with the downtown district heating system, when it was economic to run the two-mile transmission line to Cherry Hill.

The New York City Housing Authority (NYCHA) faced similar problems at 5,000 public housing units virtually across the street from the Navy Yard. Although not part of project planning in Phase I, service to these units was included in Phase II, largely at the prodding of HUD Energy Division staff. NYCHA responded favorably, to the degree that it became virtually dependent on DHC, forestalling necessary system improvements while awaiting DHC system construction.

A key issue for the NYCHA was the price to be charged for the steam. This issue led to protracted negotiations among the many parties, particularly the Housing Authority and the city's Department of General Services, the BNY operators. A key stumbling block was the inability of housing authorities to sign a take-and-pay contract under which it would be obligated to pay a fixed amount (which would assure the seller of its needed revenue), regardless of the amount actually used.

The result of the negotiations was an agreement, developed with HUD staff assistance, which establishes rates based on varying winter temperatures. A baseline charge is established for average winter temperature conditions. This schedule assures the seller of a reasonably predictable energy stream and the Housing Authority that its costs would average out about the same over an extended period of time.

This schedule was approved by HUD as a basis for reimbursing HUD for its energy costs and has been incorporated into the draft contract.

In summary, housing authorities make good district heating partners because of their concentrated heat load, stability in the community, and ability to enter into relatively long-term contracts with assurance that they will be there during the life of the contract. Significant advantages for the authorities include shedding an often onerous operating and maintenance burden with attendant savings, and elimination of capital costs for boiler and other necessary replacement.

HUD regulations that provide no payback to authorities for energy rate decreases and for sharing of savings for decrease in energy use limit incentives for linking with district heating. These rules currently are under review by the Department.

6.2 PROJECT STAGING

Risks are minimized and benefits maximized where projects are built in stages. The grandiose plans that some cities have had to build large systems all at once have given way to a recognition of the need to start small. Provo and Columbus are good examples of cities which, though unable to configure feasible large systems, found that they could configure economically feasible smaller systems. The principle they follow is to sign up a few anchor customers, build an "early start" project, and expand in stages.

Although all the cities have such ideas in mind, Springfield has the most explicit plans. It has developed a ten-year program of increasing its customer base, and tieing in to new heat sources, including the waste-to-energy facility, as new energy sources are needed.

This approach has been followed by most European cities and is being emulated in the newly-built systems in this country, including St. Paul and Trenton.

6.3 THE ISSUE OF MULTIPLE GOALS

Cities often look to DHC projects to achieve a number of objectives. Depending on local issues and opportunities, projects have been expected to lower energy costs, promote economic growth, solve waste disposal problems, lower costs of public housing, save tax dollars, and improve environmental quality. Although there is good reason to believe each of these can be accomplished, where strong advocacy positions for one or another of these goals are taken in policy oversight groups, it may be difficult and time consuming to achieve consensus and move to implementation.

The issue here appears to be less one of seeking the many benefits that DHC can accomplish, than of prioritizing goals so decisions can be reached. The project that can be developed with clear tests of success defined at the outset is more likely to focus on implementation. One that gets bogged down in trying to be all things may never get built.

7 LESSONS LEARNED

Now that these cities have generally completed Phase II work, what do we know? The reader is reminded that these eight cities were preselected because earlier studies strongly suggested that investment in Phase II studies would bear fruit, that a financeable project would be configured. In other words, these cities were judged to have a better than fair chance to succeed with DHC development.

Where are things now?

- One city, Provo, has a system operating.
- Another, Baltimore, has a new owner for an old system. Plans are in the works to expand the service territory to include the area the city feels is most in need, under the direct sponsorship of the private owner.
- Two others, Springfield and New York, have designated private developers to build projects pretty much as the city wants. Both are likely to be built soon.
- Lewiston's preferred project failed, at least for now, because it can't meet electricity prices, but one or two other cogeneration projects may be built with no city participation.
- Lawrence's project, once expected to serve much of the city, now has shrunk rather than expanded.
- Finally, two other cities are largely awaiting better fuel price conditions before they can obtain customer commitments.

In a real sense, Provo, Springfield, and New York can be claimed as clear successes of the Phase II investment, while in Baltimore and Lewiston, movement on district heating can be attributed in large part to work on Phase II, even though the specific systems are unlike original plans. In the other three, calling them failures would be inappropriate; the plans prepared under the Phase II program, and the institutional base that has been put into place await changing economic conditions before moving forward.

Lessons from what happened in these cities over the past few years can be summarized as follows:

1. A local "champion," can be a major catalyst in moving a project forward. A hands-on mayor is a big plus, but leadership can also come from a senior staff member or a visible private sector advocate.

2. From the point at which a project is conceptualized, Phase I, the work to put together the engineering and financial package takes many forms and much time. All cities must deal with issues of engineering design, marketing, pricing, financing, and government regulations, but they must develop their own work plans with sufficient content and schedule flexibility to take advantage of unforseen opportunities and to resolve unforseen problems.

3. Central plant, transmission/distribution systems, end-user retrofits must be designed uniquely for each project. Skilled, experienced, creative engineering and other talents are essential, particularly experience with similar projects. City staff is not always in a good position to evaluate consultant proposals and later, designs. There may be some benefit calling on local engineers or, perhaps, university faculty to help determine the soundness of consultant work.

4. Broadly-representative advisory groups may be useful in Phase I to build local interest and capacity, help with general concept designs, and overcome the institutional problems that arise from unfamiliarity. In Phase II, policy oversight in these cities can came from those with direct interest including city officials, probable customers and investors, and, depending on local conditions, heat suppliers. The nature of local circumstances and may be the key factor in determining the nature and degree of community involvement. The cities in this sample do not offer support for any particular approach.

5. The need for marketing in Phase II is a function of the number of customers likely to be served initially. If a small "early-start" project is being considered, the anchor customers should serve on the policy committee. If a multiple-customer system system is expected to result, more systematic marketing is necessary including, as appropriate, representation on the policy committee, preparation of marketing materials, public meetings, and individual meetings.

6. Think small at the outset. This means both to system size and its attributes. Big projects are harder to finance, may create more technical problems, increase the risk and uncertainty, and are less likely to attract outside entrepreneurs, while small, manageable systems can demonstrate the technology, obtain financing more readily, and obtain institutional support that can pave the way for later growth. And projects shouldn't try to take on too many goals. Although district heating can, in fact, help solve many problems, the focus should be on implementation. Trying to make a project accomplish too much only delays implementation.

7. Be patient. Planning a district heating project is complex and time consuming and not easily scheduled.

8. Success, i.e., implementation, is to a large degree a function of factors which must be successfully balanced to attain financial feasibility. Key factors include prices of oil and other

competitive fuels, interest rates, electricity buyback rates (for cogeneration systems), government regulation, and tax laws. These factors can change, however, making a success out of a project that now looks infeasible.

9. Although attracting a private developer limits a city's risks and liabilities, private ownership is neither a panacea nor always the best course. Cities experienced with running other utility systems, particularly electric generation and distribution, may very well use district heating to capture lost energy, increase efficiency, and lower overall energy rates.

10. Investment risks in projects should be shared among customers, developers, local governments, and investors according to the accrual of costs and benefits. No two projects will be the same in this regard and therefore "packaging" is a delicate and complex task involving negotiations among many parties. Skilled city project managers play an active and important role in bringing these parties to a successfully negotiated conclusion.

11. Public housing can be a key anchor heat load in some projects, even though current HUD policies and regulations diminish local public housing authority incentive to hook up. Local officials in such circumstances strongly favor a change that would treat DHC systems as an alternative energy conserving source whose benefits could be shared locally.

12. Solid-waste-fired district heating plants continue to be favored by system designers because they convert a liability into an asset, and they help address important regional issues. But projects must obtain long-term assurances of sufficient waste streams or obtain supplementary sources, and often must address the issue of public opposition to locating incinerators in dense inner-city locations, where their energy output is needed most.

13. The federal government role in supporting most of these projects has probably been essential in the degree of success achieved so far. Local officials and HUD staff did not always agree on objectives and work focus; nonetheless, the HUD financial and technical contribution, and the institutional support it provided, may have served as the necessary catalyst to make progress, and in some cases provided continuity that might have been lost with changes in local leadership.

Collectively, the experiences of these cities should continue to be instructive to the many others around the country now actively considering moving ahead with district heating systems.